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Division of Agricultural Sciences
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The Eighth Report in a Series on
Efficiency in Fruit Marketing

COSTS OF DUMPING INCOMING FRUIT AS RELATED TO WORK METHODS — APPLE AND PEAR PACKING HOUSES

L. L. Sammet

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FOREWORD

This is the eighth in a series of reports aimed at improved efficiency and lowered costs in the packing of deciduous fruits. The present report is concerned with a relatively small proportion of the total operations--the dumping of incoming fruit.

Data are presented for estimating the labor and equipment requirements for this operation using different types of equipment and different work methods. Comparison of total season costs with different methods indicates that hand dumping is the lowest in cost if the dumping rate per station is less than approximately 350 field lugs per hour. For higher rates of dumping per station, costs are lower with machine dumping. Savings with machine dumping increase as the length of season increases. For seasons of 250 hours in plants operating at the rate of 1,000 lugs per hour, use of a stack dumping machine--in contrast with hand dumping--may result in savings of about $1,000 per season; if the season were 500 hours in length, these savings would amount to $2,500.

These studies were made cooperatively by the Giannini Foundation of Agricultural Economics of the California Agricultural Experiment Station and the Bureau of Agricultural Economics, U. S. Department of Agriculture. They were made under authority of the Research and Marketing Act of 1946 (RMA, Title II). This act provides for studies of the costs of marketing agricultural products in their various forms and through the various channels and is designed to foster and assist in the development and establishment of more efficient marketing methods (including analyses of methods and proposed methods), practices, and facilities, for the purpose of bringing about more efficient and orderly marketing and reducing the spread between the producer and the consumer.

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Efficiency in Fruit Marketing

COSTS OF DUMPING INCOMING FRUIT AS RELATED TO WORK METHODS--APPLE AND PEAR PACKING HOUSES

L. L. Sammet[1]

INTRODUCTION

In California apple and pear packing houses, fruit is received at the packing house in field lugs containing 40 to 45 pounds of fruit. The initial step in the grading and packing process consists of dumping the contents of each lug at the packing line. The purpose of this report is to present data on the labor and equipment requirements and costs for these operations with different types of equipment and methods. As the method of dumping is closely integrated with the movement of fruit and empty lugs in the receiving area, it is necessary to make these comparisons for the joint process of receiving and dumping.

Methods Observed

Two basic methods--hand dumping and machine dumping--were observed, and with each method there were several variations. The different procedures are as follows.

Hand Dumping.--Two variations of this method are considered. In one, the full lugs are trucked to a point adjacent to the dumper in single stacks 5 or 6 lugs high or on pallets containing 30 to 36 lugs. The lugs are emptied on the dumping table and the empty lugs stacked by the dumper. Empty lugs are trucked to a storage point and later to the grower's truck. These steps in the receiving and dumping process are illustrated in Figure 1A. In the second method, two aids to the dumper are introduced. Full lugs are trucked to a conveyor belt leading to the dumping station. The lugs are placed on the belt by a seton man; each lug is emptied by the dumper who then places the empty lug on a conveyor leading to the empty-lug storage area. At this point, the empty lugs are set off and stacked then trucked to a temporary storage and, later, to the grower's truck. The steps in this process are illustrated in Figure 1B.

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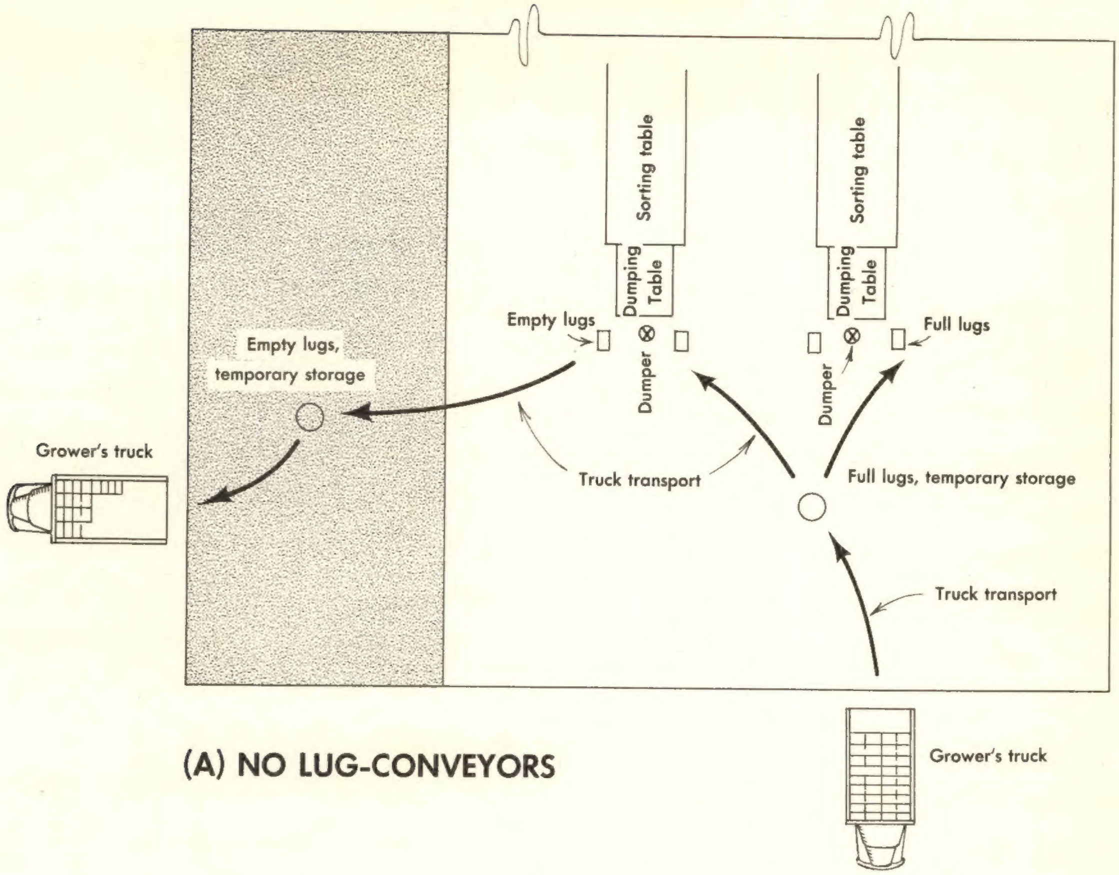
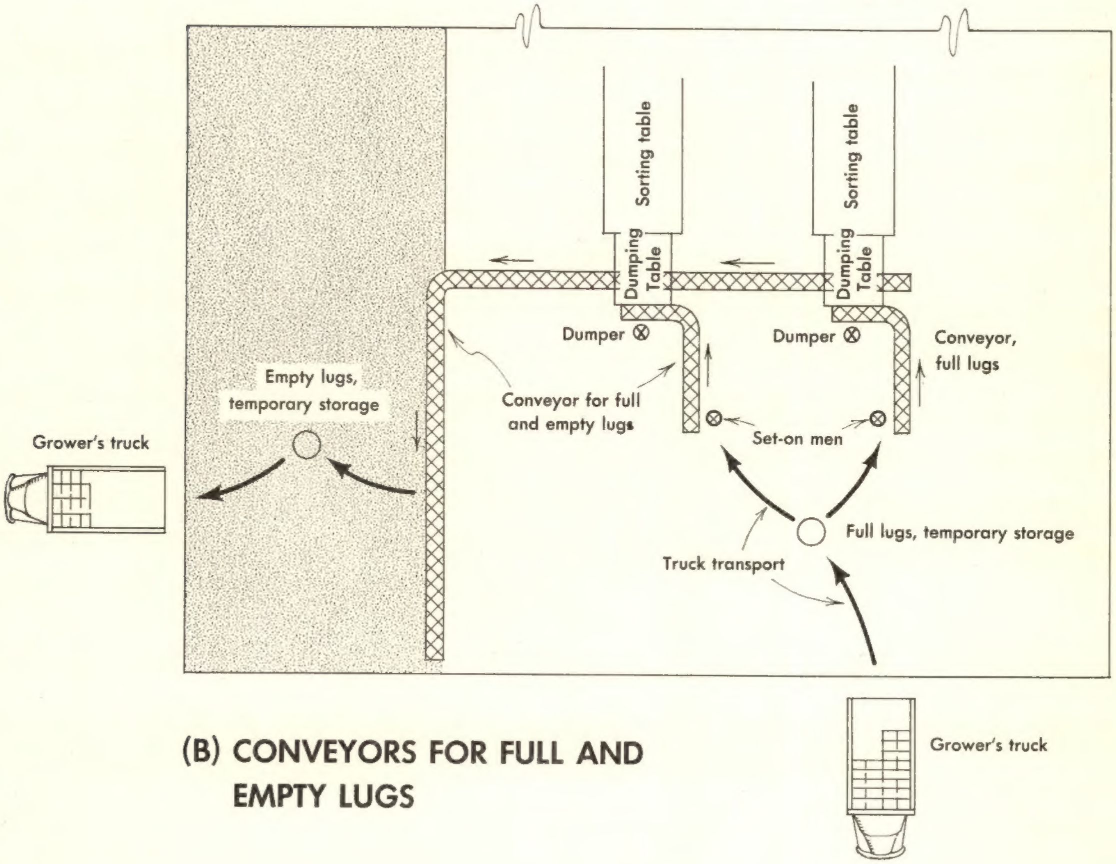
[1] Cooperative Agent of the California Agricultural Experiment Station and the Bureau of Agricultural Economics, U. S. Department of Agriculture.



(A) NO LUG-CONVEYORS



(B) CONVEYORS FOR FULL AND EMPTY LUGS

Figure 1. Typical plant layout and movement of fruit and field lugs in the receiving and dumping operations in apple and pear packing plants.

Machine Dumping.--The steps in the machine-dumping process are similar to those outlined for hand dumping using conveyors for full and empty lugs, except that a dumping machine is used to empty the full lug and to place the empty lug on a conveyor to the lug storage area. One type of dumping machine--the single-box dumper--receives single lugs of fruit from a conveyor, and the receiving and dumping crew consists of seton men for full lugs and setoff men for empty lugs in addition to the truckers. With a second type of machine--the stack dumper--the full lugs are carried into the dumping machine in stacks 5 or 6 lugs high by a floor chain conveyor. The stacks are placed on the floor chain by a hand trucker, and the crew consists only of truckers and empty-lug setoff men. Except for the operations performed mechanically, the process with machine dumping is similar to that illustrated in Figure 1B.

Several other variations in the above methods are possible. With hand dumping, for example, higher rates of output can be achieved if the dumper alternates with a worker on some other job, for example, a trucker or seton man. Still higher rates of output may be achieved if, in addition to providing alternate work for the dumper, extra rest time is provided.

Requirements for labor and equipment and estimates of costs with the above methods are presented in the following discussion.

Dumping Methods--Effect on Bruising

Although the emphasis in this report is on costs, an important aspect of the problem is the relative quality of the work done with different methods. In the dumping operation, the principal requirement regarding quality is to avoid bruising the fruit. In this respect, the relative performance with hand-dumping and machine-dumping methods depends on the care used in hand dumping, the performance characteristics of the machine dumper, and the rate of dumping. From general observation and from limited studies of this problem, it appears that careful operation with either method will yield about the same results in regard to quality. A possible exception is the chain dumper--a variation of the single-box machine dumper (see Figure 7, page 21). More difficulty with bruising might be expected with this machine than with careful hand dumping or with other types of machine-dumping equipment. With all methods, a dumping arrangement in which the fall of the fruit is cushioned in a water tank appears to reduce damage to the fruit, although the water should be changed frequently to prevent contamination.[2] In the cost comparisons that follow, it is assumed that differences in

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[2] See Apple Research Digest, October, 1949, Washington State Apple Commission, Yakima, Washington.

bruising can be kept small enough so that special consideration of this factor may be omitted. It should be stressed, however, that where variations in the amount of bruising do result from the dumping methods used this factor must be evaluated in any cost comparisons.

Labor Cost of Dumping in Sample Plants

Labor utilization and costs per 1,000 pounds of fruit dumped in 15 California apple and pear packing plants are given in Table 1. In general, labor use is lowest in the group of plants using the hand-dumping method without conveyor aids. Labor use is largest in the plants using the hand-dumping method, plus aids in the form of conveyors for full and empty lugs.

The dumping labor costs given in Table 1 are based on standardized wage rates selected as representative for the industry. In terms of these standardized costs, the range is from $0.095 to $0.241 per 1,000 pounds of fruit for the hand-dumping method without conveyor aids and from $0.147 to $0.335 per 1,000 pounds of fruit in the hand-dumping operations using conveyor aids. Costs for dumping labor in the plants using machine dumping were $0.151 and $0.188 per 1,000 pounds of fruit dumped.[3] If the labor cost comparisons were based on wage rates actually paid in each plant, the variations in costs between plants would be greater, although the general indications as to relative costs with different methods would not be different. Labor costs based on actual wage rates would be relatively lower in apple packing plants than in pear packing plants because of generally lower wage rates in the apple packing plants.

In itself, the dumping operation does not comprise a large proportion of the total direct plant labor. Based on the standardized costs for dumping labor and total direct labor given in Table 1, the dumping labor cost ranges from 2.1 per cent of the total direct labor cost in Plant B to 5.4 per cent in Plant H. The dumping method, however, also affects the costs of moving incoming fruit, and when these operations are considered jointly, the problem assumes more significance.

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[3] The usual expectation of lower labor cost with mechanized equipment fails to materialize in this instance--labor costs with the single-box dumping machines are higher than with the hand-dumping method without conveyor aids. This is explained by the fact that the hand-dumping operation is performed with one handling of the lug, while the single-box dumping machine requires two handlings per lug—one by the full-lug seton man and another by the empty-box setoff man. Each of these operations taken alone requires less labor than the complete hand-dumping operation, but their sum is greater. The net effect is a rate of operation per dumping station greater than with hand dumping but at higher cost. Similarly, the labor cost of hand dumping with conveyor aids is still greater as with this method each lug is handled three times.

TABLE 1

Selected Costs for Dumping Labor and for Total Direct Labor in Fifteen California Apple and Pear Packing Plants

Plant[a/]	Dumping labor, hours per 1,000 pounds	Labor cost with standardized wages		Standardized dumping labor costs as a percentage of total plant labor
		Dumping	Total direct plant labor	
		dollars per 1,000 pounds		
	Hand dumping			
A	.114	.153	6.455	2.37
B	.105	.141	6.619	2.13
D	.094	.126		
F	.079	.107	4.870	2.20
H[b/]	.179	.241	4.488	5.37
V[c/]	.073	.095	3.880	2.45
	Hand dumping with full-lug and empty-lug conveyors			
L	.258	.335	7.089	4.73
M	.161	.208	4.000	5.20
N	.203	.261	6.554	3.98
P	.162	.205	5.658	3.62
Q	.195	.247	6.258	3.95
S	.142	.183	5.298	3.45
R[d/]	.116	.147	4.559	3.22
U[e/]	.151	.166	5.038	3.29
	Machine dumping			
T[f/]	.132	.188	3.593	5.23
W	.123	.151	4.264	3.54

[a/] Plants A to H are apple packing plants; remainder are pear packing plants.

[b/] Two men per dumping station.

[c/] Dumper alternates with worker on another job.

[d/] Empty-lug conveyor but no conveyor for full lugs.

[e/] Dumper alternates with worker on another job; also has rest time equivalent to 20 per cent of total work time.

[f/] At capacity operation, one line is supplied by hand dumping with two dumpers working as a team.

ESTIMATING COSTS OF LABOR AND EQUIPMENT FOR RECEIVING AND DUMPING

The estimates of labor and equipment costs which follow for several different methods of receiving and dumping fruit are based on standardized production and cost rates.[4] Two elements of cost are included--direct costs for labor and equipment and fixed costs for equipment.

Direct and Fixed Costs

The direct costs include the cost of labor, equipment repair expenses directly attributable to use, and the cost of power for mechanical equipment. The rates used for labor range from $1.10 per hour for empty-lug setoff men to $1.35 per hour for dumpers. These are selected rates which appear to be typical for the industry. The cost of electric power is estimated at the rate of $0.03 per motor horsepower, and the cost of direct repairs for equipment is estimated as 0.5 per cent of the replacement cost per 100 hours of use.[5]

Annual fixed costs for equipment are estimated as a percentage of the 1950 replacement cost. Shipping costs and estimates of the labor and materials required for installation are included in the estimated cost of replacement. The percentage annual charge includes the following: insurance, 1.0 per cent; taxes, 1.0 per cent; interest, 3.0 per cent;[6] fixed repair expense, 1.5 per cent; and a depreciation percentage based on the estimated use life of the equipment. The depreciation rates used for the various types of equipment are as follows: gravity conveyors, 5.0 per cent; power conveyors and hand trucks, 6.7 per cent; and fork trucks, 10.0 per cent.

The cost estimating procedure can be illustrated by an example. Consider the method of hand dumping without conveyor aids. Excluding the trucking operations, the labor and equipment requirements per dumping station consist of a dumper and a dumping table. The estimated dumping costs are:

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[4] For a more detailed discussion of the basic cost and production data, see Appendix A.

[5] Adequate data on repair costs are not available, and this necessitates a somewhat arbitrary allocation of repair expenses. In the procedure outlined above, it is recognized that deterioration is a function of both time and use. Hence, part of the estimated repair expense is included with the annual fixed cost. In addition, an estimated amount is included as a direct charge per hour of equipment use.

[6] Approximately 5.0 per cent of the undepreciated balance of the investment.

Fixed costs		
Replacement cost for dumping table	$500	
Annual fixed cost (13.5 per cent of replacement cost)	$ 68	
Direct costs		
Dumping labor		$1.35 per hour
Direct equipment repair (0.5 per cent of replacement cost per 100 hours of use)		$0.02 per hour
Power cost (for operation of elevator to sorting table, ½ horsepower at $0.03 per horsepower hour)		$0.02 per hour
Total		$1.39 per hour

Production Standards

The amounts of labor and equipment required with a given rate of dumping are estimated by means of unit time requirements for the various operations. These unit time requirements--for example, the time required by the dumper to obtain and empty a full lug and to dispose of the empty lug--were derived from studies of actual plant operations. These studies give the net time requirements. To obtain the actual work time per unit, the net time must be adjusted to allow for nonproductive time.

The amount of nonproductive time varies in different plants. There is a customary allowance of regular ten-minute rest periods for each four hours of work time, and this amounts to 4.2 per cent of the total work time. In addition, there are unavoidable delays and, in some plants, lost time due to the break between lots of fruit from different growers.[7] In the plants studied, unavoidable delay ranged from 1.0 to 15.9 per cent of the total work time and averaged 6.3 per cent. Break-for-lots time ranged from 3.0 to 28.1 per cent of the total work time and averaged 9.3 per cent. Using the percentage of customary rest time and the average percentage time loss for the remaining delays, the total nonproductive time is approximately 20 per cent of the total work time.

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[7] The break between lots consists of the period between lots of fruit from different growers when the dumping operations are suspended to permit the lots to be processed separately. This procedure is the means of accounting to the grower for the quantity and grade of fruit delivered. In some plants, a sampling procedure is used which eliminates the break-for-lots delay.

For more detail regarding break-for-lots delays, see Economy and Accuracy in Accounting to Growers for Fruit Received at the Packing House. Berkeley, 1953. (Calif. Univ. Giannini Foundation of Agricultural Economics. Mimeographed Report 149)

In this report, the total work per work unit is obtained by adjusting the observed net time by the above percentage. For example, the typical net time required to transfer a full lug from a stack on the floor to a conveyor is 0.104 man-minutes per lug. The total work time required is estimated as 0.104/0.80 = 0.130 man-minutes. This unit time requirement may also be expressed in terms of capacity per worker per hour. In the above example, the capacity rate is 60/0.130 = 460 lugs per hour. This is the rate applicable if the transfer is made from a stack on the floor. If the transfer is made from a pallet, the unit time is greater by approximately 0.004 man-minutes per lug to allow for handling the empty pallet. In this case, the total time required per lug is 0.135 man-minutes, and the capacity rate is 440 lugs per hour.

Similarly, capacity rates may be estimated for other jobs in the dumping crew and for the trucking operations.

It should be emphasized that the cost data and production standards used in this report may not be specifically applicable to a particular plant. Replacement costs for equipment, for example, vary with such factors as time of purchase, locality, and terms of sale. Similarly, the particular cost rates appropriate for calculating labor and equipment costs may vary from plant to plant. In addition, variation in output may be expected with different workers. The cost data and production standards that are used in the following analyses are believed, however, to be representative of costs and production rates in the industry. The studies based on them should indicate reasonably well the relative costs with different methods.

In the discussion that follows, estimates of labor and equipment requirements and costs are given for several different dumping methods. This is followed by an analysis of requirements and costs for the trucking operations required in receiving with each dumping method. These results are then combined to provide a comparison of the effect of different dumping methods on total dumping and receiving costs.

Method A--Hand Dumping Without Conveyor Aids

With this method, the dumper is unaided except for the possibility of alternating with a worker on a different job, such as a trucker. The dumper obtains the full lug from a stack on the floor, or pallet, empties the lug and restacks the empty lug (Figure 2). Considering only the dumping operations--and assuming that the dumper alternates with the trucker--the capacity dumping rate per station and the equipment requirements and replacement costs would be as follows:

Method A

Job classification	Capacity rate	
	From floor	From pallet
	lugs per hour	
Dumper: Lifts a full lug from a stack on the floor, or pallet, empties the lug, and restacks the empty lug	350	340
Equipment requirements per dumping station	Estimated quantity	Replacement cost, 1950[a]
Dumping station: Table and elevator to sorting table	1	$500

[a] In this and the following summaries, the cost estimates are based on the prevailing prices for labor and equipment in 1950. Since then, the level of prices for labor and equipment has risen about 10 per cent, but the relative costs with different methods has not changed greatly.

Labor and equipment requirements and costs using dumping Method A--and assuming that the dumper alternates with the trucker--are presented for different rates of plant operation in Table 2. The estimates are worked out on a step-by-step basis by adding an additional worker and dumping station as the capacity rate of the dumper is reached. The dumping rates at which these additions occur are given in the columns at the left of the table. Different capacity rates are indicated for plants using hand trucks and fork trucks for the trucking operations. Thus, the initial step provides for dumping rates up to 350 lugs per hour in the plants using hand trucks and a rate of 340 lugs per hour in the palletized fork-truck plants. Similarly, the capacity dumping rates for two dumping stations are 700 lugs per hour in the hand-truck plants and 680 lugs per hour in the fork-truck plants. The estimates of dumping costs given in Table 2 are computed from the equipment requirements per station and the equipment cost rates previously given and from crew requirements and wage rates indicated in the table. With two dumping stations, for example, the direct costs are: labor, $2.70 per hour; electric power and equipment repair, $0.08 per hour; and total direct costs,

TABLE 2

Hand Dumping--Method A: Dumping Labor and Equipment Requirements and Costs in Relation to Capacity Dumping Rate, Apple and Pear Packing Plants

Number of dumping stations	Crew capacity[a/]		Job and number of workers[b/]	Direct cost			Equipment cost	
	Hand-truck plant	Fork-truck plant	Dumper	Labor	Equipment (power and repairs[c/])	Total	Replacement cost[d/]	Annual fixed cost[e/]
	lugs per hour			dollars per hour			dollars	
1	350	340	1	1.35	0.04	1.39	500	68
2	700	680	2	2.70	0.08	2.78	1,000	135
3	1,050	1,020	3	4.05	0.12	4.17	1,500	203
4	1,400	1,360	4	5.40	0.16	5.56	2,000	270
5	1,750	1,700	5	6.75	0.20	6.95	2,500	338
6	2,100	2,040	6	8.10	0.24	8.34	3,000	405

a/ Capacity dumping rate, assuming dumper alternates with trucker and that nonproductive time is 20 per cent of total work time.

b/ Wage rate: dumper, $1.35 per hour.

c/ Estimated as 0.5 per cent of replacement cost per 100 hours of use; power cost estimated at $0.03 per hour per motor horsepower.

d/ Price level for 1950.

e/ Estimate based on percentage of replacement cost; for dumping table = 13.5 per cent.

$2.78 per hour. The replacement cost for equipment is $1,000, and annual fixed costs for equipment, at a percentage rate of 13.5, are $135. These cost estimates may then be used to compute total costs per season. For example, if the plant were to operate 200 hours per season, the total season cost would be the annual fixed cost of $135 plus direct costs of $556 to make a total cost of $691 per season. Similarly, season total costs could be estimated for other rates of operation and for different lengths of season.

The cost relationships presented in Table 2 are shown graphically in Figure 3. In this chart, total season costs are given in relation to capacity dumping rates in hand-truck and fork-truck plants. The dumping rate is shown on the horizontal scale, and total season costs for the dumping operations are shown on the vertical scale. Two sets of cost lines are indicated, one for 200 hours of operation per season and the other for 400 hours of operation. In each set, two cost lines are given. The "step" cost line represents season costs at the capacity rates of receiving indicated in Table 2 for different crew sizes. While this step cost line indicates the costs that would result with the crew and equipment specified in Table 2, it is likely that in actual plant operation crew adjustment would be made over a range of dumping rates rather than at the precise points shown.[8/]

If costs in a number of plants of a given size are considered, adjustment in crew size in a particular plant would be expected in the "neighborhood" of the steps indicated in Figure 2. The average cost situation in these plants then would be at some intermediate point between the high- and low-cost points in each step. Such "average" costs are represented by the uniformly sloping cost lines in Figure 3. If, for example, the dumping rate with hand-truck receiving were 1,000 lugs per hour, these cost lines indicate total season costs of approximately $800 with 200 hours of operation per season and $1,400 with 400 hours of operation per season. These smoothed lines are more convenient for comparing costs with different methods and are used for this purpose in later sections of this report.

[8/] There are several reasons for this kind of adjustment. There is the normal variation in output to be expected from different workers. In some instances, a rate of output higher than normal might be induced by paying more than the going wage. Moreover, some integration of workers on different jobs may be achieved, thus reducing the amount of nonproductive work time.

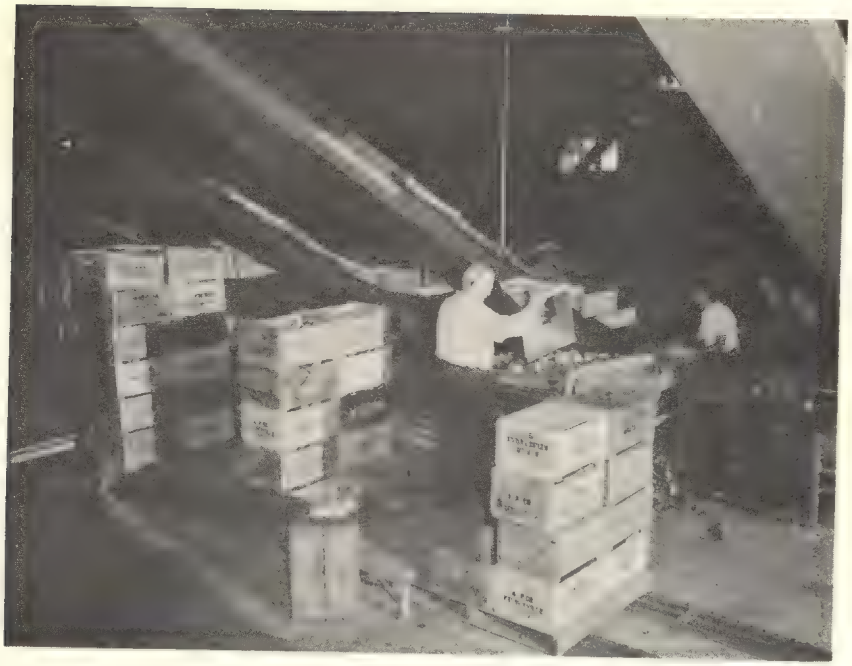

Figure 2. Hand dumping without conveyor aids—Method A. (Note that lugs are supplied to the dumper on pallets—full lugs on the dumper's left and empty lugs on the right. The pallets rest on roller conveyors on the floor and the full-lug pallet is pulled under the dumping platform as pallet is emptied, thus reducing the reach required. Empty pallets pass under the dumping platform and on to the right as the pallet is filled with empty lugs.

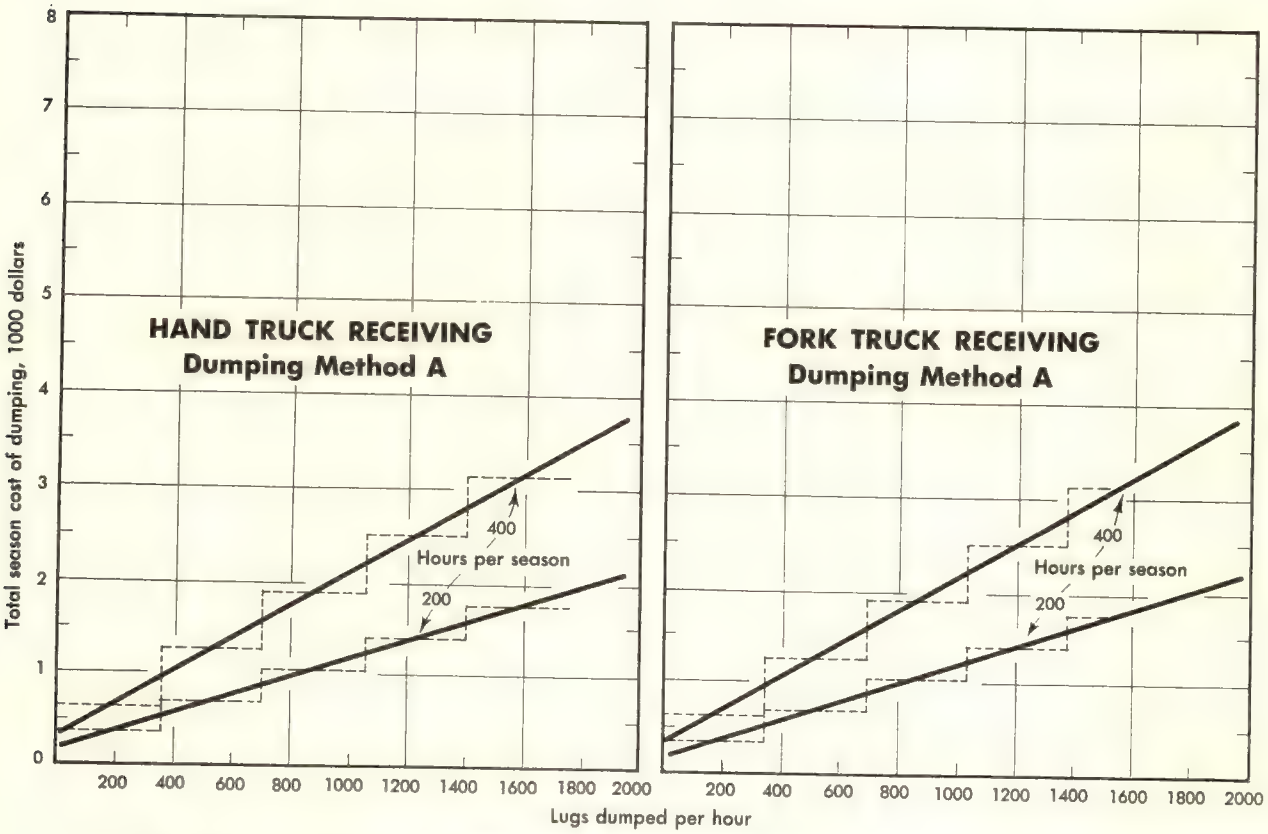

Figure 3. The effect of rate of operation on total season dumping costs with hand dumping (no conveyor aids, but trade with trucker)—Method A.

Method B--Hand Dumping With Conveyor Aids

In this method, the field lugs are dumped by hand, but the dumper is aided by means of conveyors for full and empty lugs (Figure 4). The different job classifications, the capacity rate of operation for each job, and equipment requirements per dumping station are as follows:

Method B

Job classification	Capacity rate From floor	 From pallet
	lugs per hour	
Seton man:		
Places the full field lug on a conveyor leading to the dumper (alternates with dumper)	460	445
Dumper:		
Receives the full lug on the conveyor at waist height, empties the lug, and places it on an empty-lug conveyor leading to the lug-storage area (alternates with seton man)	460	445
Setoff man:		
Removes empty lugs from the conveyor and stacks them on the floor or on a pallet	585	555
Equipment requirements per dumping station	**Estimated quantity[a]**	**Replacement cost, 1950**
Seton conveyor	25 feet	$530
Dumping station:		
Table and elevator to sorting table	1	$500
Empty-lug conveyor:		
Power conveyor	30 feet	$530
Gravity conveyor	40 feet	$125

[a] For a one-station plant. The average quantities per station vary slightly with the number of dumping stations.

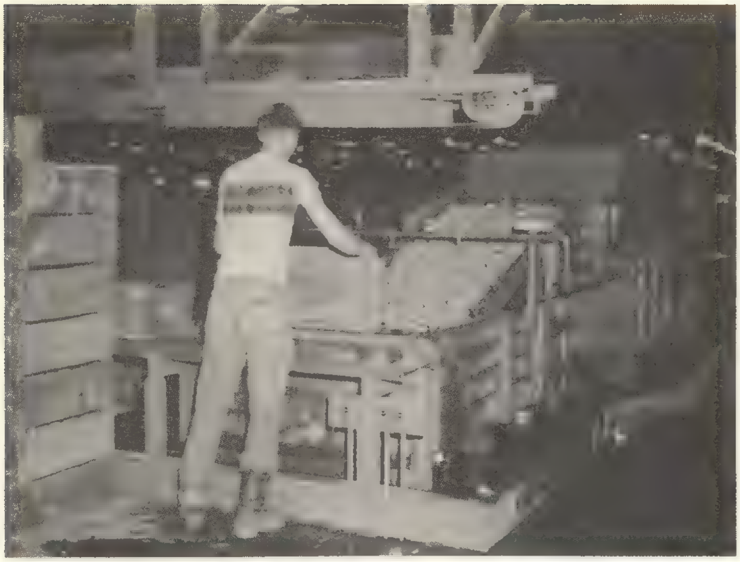

Figure 4. Hand dumping with conveyor aids—Methods B and C. The full lug comes to the dumper from the left on a conveyor at waist-height. The empty lug is placed on the overhead conveyor which transports it to the empty-lug storage area.

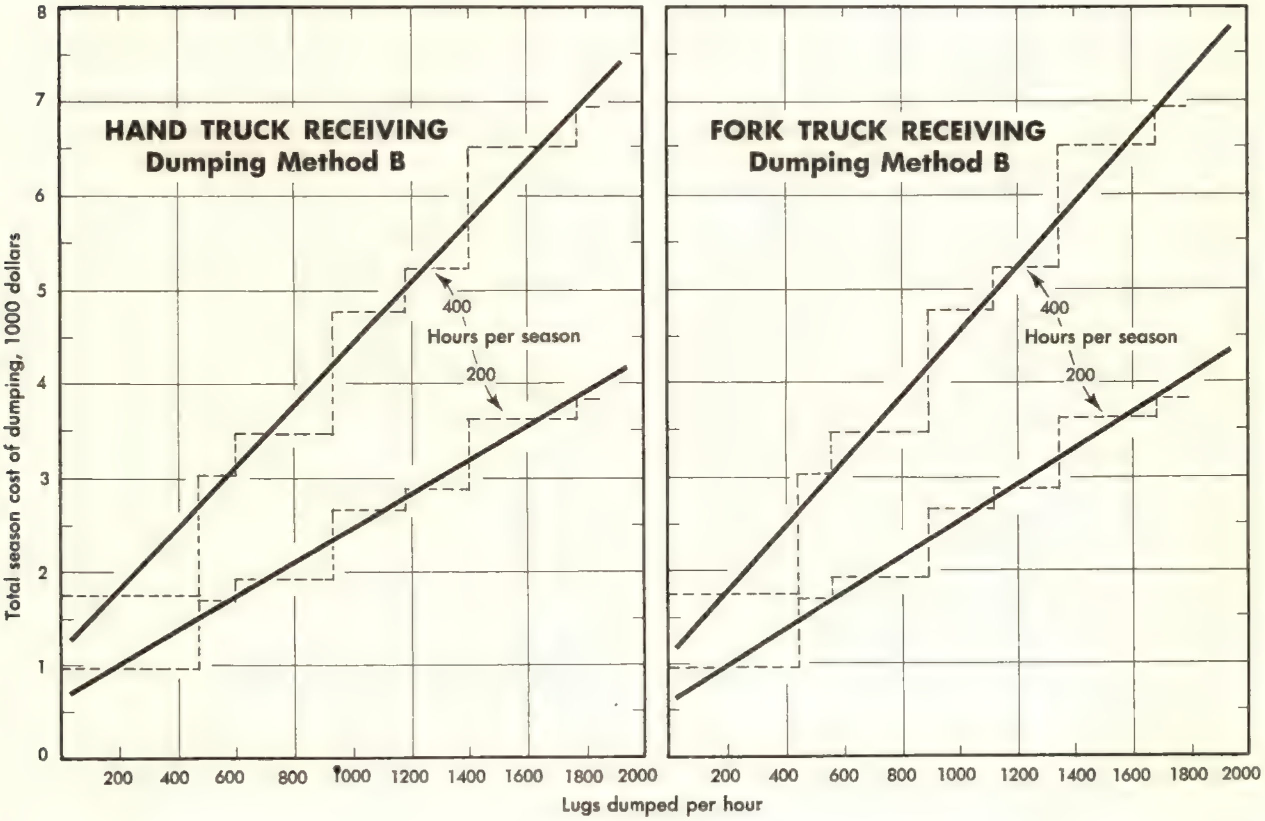

Figure 5. The effect of rate of operation on total season dumping costs with hand dumping, using conveyor aids—Method B.

TABLE 3

Hand Dumping--Method B: Dumping Labor and Equipment Requirements and Costs in Relation to Capacity Dumping Rate, Apple and Pear Packing Plants

Number of stations	Crew capacity a/		Job and number of workers b/			Direct cost			Equipment cost	
	Hand-truck plant	Fork-truck plant	Dumper	Set-on	Set-off	Labor	Equipment (power and repairs c/)	Total	Replacement cost d/	Annual fixed cost e/
	lugs per hour					dollars per hour			dollars	
1	460	445	1	1	1	3.80	0.09	3.89	1,470	198
2	585	555	2	2	1	6.50	0.17	6.67	2,853	385
2	920	890	2	2	2	7.60	0.17	7.77	2,853	385
3	1,170	1,110	3	3	2	10.30	0.26	10.56	4,236	572
3	1,380	1,335	3	3	3	11.40	0.26	11.66	4,236	572
4	1,755	1,665	4	4	3	14.10	0.34	14.44	5,619	759
4	1,840	1,780	4	4	4	15.20	0.34	15.54	5,619	759

a/ Capacity dumping rate, assuming dumper alternates with seton man and nonproductive time is 20 per cent of total work time.
b/ Wage rates: dumper, $1.35; seton, $1.35; and setoff, $1.10.
c/ Estimated at 0.5 per cent of replacement cost per 100 hours of use; power cost estimated at $0.03 per hour per motor horsepower.
d/ Price level for 1950.
e/ Estimate based on percentage of replacement cost; for dumping table and conveyors= 13.5 per cent.

Costs for the labor and equipment required for the dumping operations with this method are summarized for different rates of output in Table 3. In plants using hand trucks for receiving, for example, the dumping crew required for a capacity rate of 1,170 lugs per hour consists of three dumpers, three seton men, and two setoff men. The direct costs, including labor, power, and direct equipment repair expense, are $10.56 per hour. Annual fixed costs for equipment are $572. If fork trucks are used for the trucking operations, the capacity dumping rate corresponding with these costs is 1,110 lugs per hour.

The relation of costs to capacity dumping rate is shown graphically in Figure 5. As with Method A, total costs per season in relation to capacity dumping rate are given for 200 and 400 hours of operation per season. Two cost lines are shown in each case--a step cost line reflecting the costs with different crew sizes and capacity rates given in Table 3 and a uniformly sloping line representing the "average" cost situation. Using the "average" cost line for a plant operating with hand trucks and at the rate of 1,000 lugs per hour, total costs for labor and equipment are $2,500 per season with 200 hours of operation per season and $4,500 with 400 hours of operation per season. Costs for other dumping rates and for different lengths of season can be calculated from the data in Table 3.

Method C--Hand Dumping With Conveyor Aids Plus Relief

In some plants, the required rate of dumping per station exceeds the capacity for hand dumping with Method B. One means of increasing the dumping rate per station is to provide additional rest for the dumper, thus, allowing him to operate at an accelerated pace while actually working. Estimates of costs based on this procedure are given in Table 4 and Figure 6. The estimates are based on dumping rates applicable when the additional rest time is approximately 20 per cent of the total work time. For one dumping station, the "dumping crew" would consist of one seton man, one dumper, two truckers, and one relief man. This five-man crew then rotates through the various jobs with one of the five men always in a rest status.

With the addition of the relief element, the capacity rate for the dumper and seton man (in plants using hand trucks) increases from 460 lugs per hour with dumping Method B to 610 lugs per hour with dumping Method C. There also is a substantial change in the conveyor requirements. While the requirements for the lug conveyors would increase only slightly, the increased dumping rate would require--in most plants--the addition of a fruit distribution belt for sorted fruit. This change is necessary because a rate of dumping of 610 lugs per hour would exceed the normal capacity of the usual "packing line," unless the proportion of cull and cannery fruit was unusually high. A distribution belt for loose fruit then would be necessary in order to route sorted fruit to two, or more, different packing lines.[9]

The various job categories, capacity rates, and equipment requirements for this method are as follows:

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[9] An equally logical allocation of costs for the fruit distribution belt would be to charge this expense to the larger sorting table. If this were done, the annual fixed costs would be less by approximately $100 per dumping station, and direct costs would be less by $0.04 per station. In a two-station plant operating 200 hours per season, this would amount to a total reduction in dumping costs of $216 per season. If such a reallocation were made, it would also apply to Methods D and E which follow.

Method C

Job classification	Capacity rate From floor	 From pallet
	lugs per hour	
Seton man: Places full field lugs on a conveyor leading to the dumper--alternates with dumper, trucker, and relief	640	605
Dumper: Receives full lugs on conveyor, empties lug, and places empty lug on conveyor--alternates with seton, trucker, and relief	610	610
Setoff man: Removes empty lugs from conveyor and stacks them on the floor or on a pallet	585	555
Relief: Alternates with dumper, seton, and trucker	--	--
Trucker: Alternates with dumper, seton, and relief	--	--

Equipment requirements per dumping station	Estimated quantity[a]	Replacement cost, 1950
Seton conveyor	35 feet	$620
Dumping station:		
Table and elevator to sorting table	1	$530
Empty-lug conveyor:		
Power conveyor	40 feet	$560
Gravity conveyor	48 feet	$150
Fruit distribution belt	30 feet	$730

[a] For a one-station plant. The average quantities per station vary slightly with the number of stations.

Costs for the labor and equipment needed for the dumping operations only--omitting the trucking requirements and the costs of work done by the dumping crew while alternating as truckers--are given for different dumping rates and the corresponding crew organization in Table 4.

TABLE 4

Hand Dumping--Method C: Dumping Labor and Equipment Requirements and Costs in Relation to Capacity Dumping Rate, Apple and Pear Packing Plants

Number of stations	Crew capacity a/		Job and number of workers b/				Direct cost			Equipment cost	
	Hand-truck plant	Fork-truck plant	Dumper	Set-on	Relief	Set-off	Labor	Equipment (power and repairs c/)	Total	Replacement cost d/	Annual fixed cost e/
	lugs per hour						dollars per hour			dollars	
1	585	555	1	1	1	1	5.15	0.14	5.29	2,470	333
1	610	590	1	1	1	2	6.25	0.14	6.39	2,470	333
2	1,170	1,110	2	2	1	2	8.95	0.27	9.22	4,780	645
2	1,220	1,180	2	2	1	3	10.05	0.27	10.32	4,780	645
3	1,755	1,655	3	3	2	3	14.10	0.40	14.50	7,090	957
3	1,830	1,770	3	3	2	4	15.20	0.40	15.60	7,090	957
4	2,340	2,220	4	4	2	4	17.90	0.53	18.43	9,400	1,269

a/ Capacity dumping rate, assuming dumper, seton men, and truckers alternate and extra rest time is approximately 20 per cent of total work time.

b/ Wage rate: dumper, $1.35; seton, $1.35; relief, $1.35; setoff, $1.10 per hour.

c/ Estimated as 0.5 per cent of replacement cost per 100 hours of use; power cost estimated at $0.03 per hour per motor horsepower.

d/ Price level for 1950.

e/ Estimate based on percentage of replacement cost; for dumping table and conveyor = 13.5 per cent.

These costs are shown graphically in Figure 6. As with the previous methods, the graphs show total season costs in relation to dumping rate, and both the step cost lines and cost lines representing the "average" situation are given. If costs with this and the preceding methods are compared for a given dumping rate, only minor differences are indicated. The higher costs per station are offset by the increased dumping rate per station.

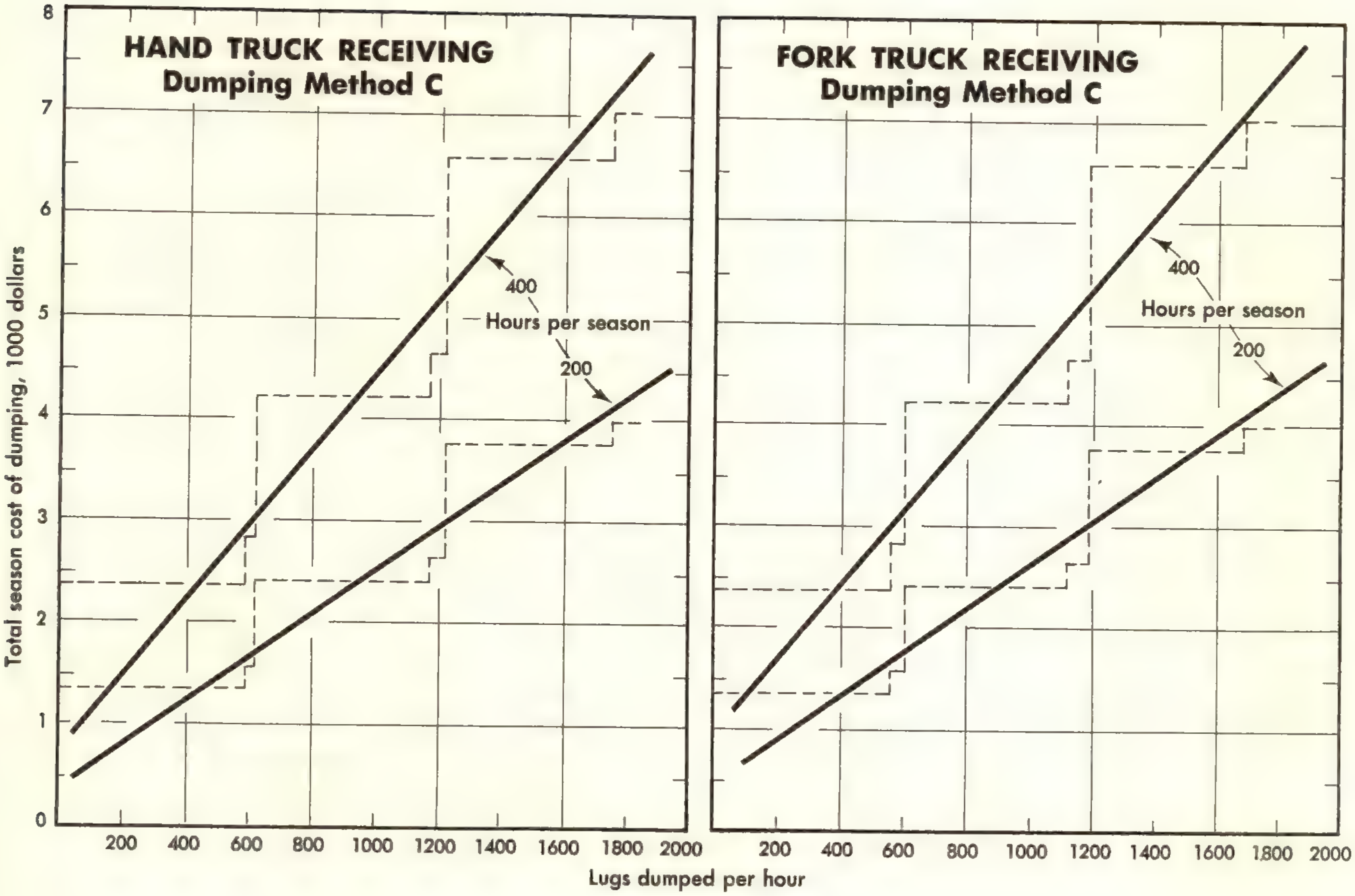


Figure 6. The effect of rate of operation on total season dumping costs with hand dumping, using conveyor aids plus extra rest time—Method C.

Method D--Single-Box Machine Dumper

The dumping operations with this method are similar to those in Method B--hand dumping with conveyor aids--except that the full lug is fed into a dumping machine which automatically dumps the contents and places the empty lug on the empty-lug conveyor (Figure 7). The dumping crew then consists only of the seton men for full lugs and setoff men for empty lugs. As the seton man works at a point near the dumping machine, such supervision of the machine operation as is required--for example, to stop the machine in the event of jamming--can be performed by the seton men. Hence, no special labor for machine care is required.

The various job categories, capacity rates, and equipment requirements per dumping station are summarized below. In this summary, a range in replacement

Method D

Job classification	Capacity rate	
	From floor	From pallet
	lugs per hour	
Seton man: Places full field lug on a conveyor leading to the dumping machine	460	445
Setoff man: Removes empty lugs from conveyor and stacks them on the floor or on a pallet	585	555

Equipment requirements per dumping station	Estimated quantity[a]	Replacement cost, 1950
Dumping machine	1	$1,100 to 2,600
Dumping table	1	$ 500
Seton conveyor	35 feet	$ 620
Empty-lug conveyor:		
Power conveyor	40 feet	$ 560
Gravity conveyor	48 feet	$ 150
Fruit distribution belt	30 feet	$ 730

[a] For a one-station plant. The average quantities per station vary slightly with the number of stations.

costs for the dumping machine is indicated, reflecting costs for machines of different manufacturers and differing as to mechanical details. With each type of machine, a variable speed drive is provided so that the rate of dumping can be varied over a considerable range. The machine capacities as estimated by the manufacturer ranged from 720 to 1,000 lugs per hour. For the analysis in this report, the capacity rate has been standardized at what is considered a good "working" rate of 750 lugs per hour. With a 20-per cent delay proportion applied to the dumping crew, this results in an effective rate of 600 lugs per hour.

Estimates of the direct costs for labor and equipment and of the annual fixed costs for the dumping operations only are given in Table 5 for different dumping rates in plants using fork trucks or hand trucks in the receiving operations. These costs are also shown in Figure 8. As in the preceding diagrams, both a step cost line reflecting the costs given in Table 5 and a cost line representing the "average" situation are presented.

For simplicity, the costs given in Table 5 are based on the lower replacement cost indicated above for dumping machines. If the higher machine cost were used, the annual fixed costs per dumping station would be greater than indicated by about $200 per dumping station, and the direct costs would be greater by about $0.08 per station. The use of the lower replacement cost should, however, give a satisfactory indication of the relative costs with different methods. Presumably, the low-cost machine would be chosen, unless the higher cost machine were superior in terms of capacity or quality of performance--or unless the rate of depreciation and expected operating costs were lower by an amount sufficient to offset the higher initial cost. On this basis, a cost analysis in terms of the low-cost machine is appropriate.

Two advantages in the use of the machine-dumping methods may influence costs although their effects would be difficult to measure and are not evaluated in this report. A more even flow of fruit to the sorting table is possible with machine dumping, and changes in dumping rate with variations in fruit quality are more easily controlled. These effects appear to result in a small increase in the efficiency of the sorting operations. Also, the dumping job is considered particularly arduous and the use of dumping machines simplifies the problem of recruiting workers.

TABLE 5

Machine Dumping, Single Box--Method D: Dumping Labor and Equipment Requirements and Costs in Relation to Capacity Dumping Rate, Apple and Pear Packing Plants

Number of dumping stations	Crew capacity[a/]		Job and number of workers[b/]		Direct cost			Equipment cost	
	Hand-truck plant	Fork-truck plant	Seton	Setoff	Labor	Equipment (power and repairs[c/])	Total	Replacement cost[d/]	Annual fixed cost[e/]
	lugs per hour				dollars per hour			dollars	
1	460	445	1	1	2.45	0.23	2.68	3,660	494
1	585	555	2	1	3.80	0.24	4.04	3,660	494
1	600	600	2	2	4.90	0.25	5.15	3,660	494
2	920	890	2	2	4.90	0.46	5.36	7,145	965
2	1,170	1,110	3	2	6.25	0.48	6.73	7,145	965
2	1,200	1,200	3	3	7.35	0.49	7.84	7,145	965
3	1,380	1,335	3	3	7.35	0.68	8.03	10,630	1,435
3	1,755	1,665	4	3	8.70	0.72	9.42	10,630	1,435
3	1,800	1,780	4	4	9.80	0.73	10.53	10,630	1,435
3		1,800	5	4	11.15	0.73	11.88	10,630	1,435

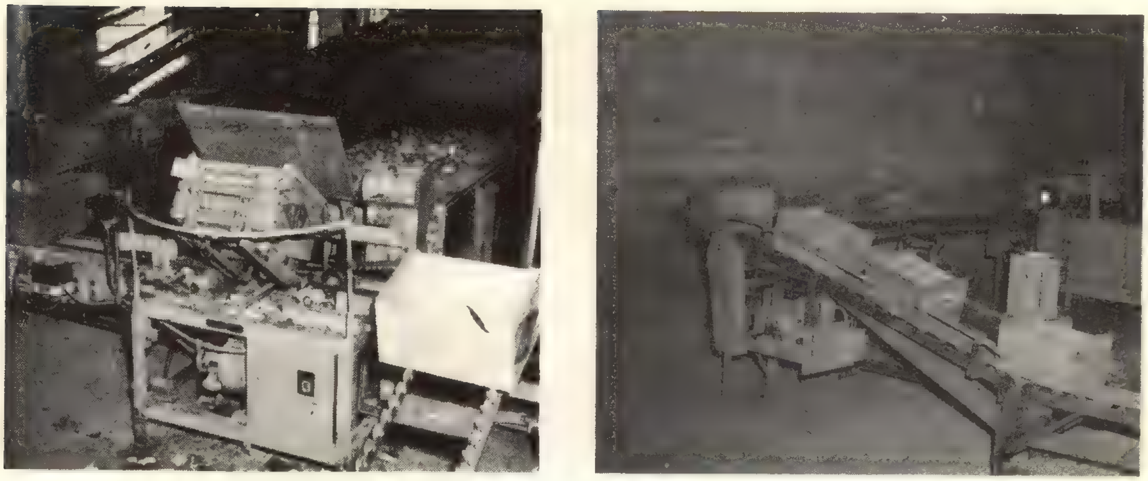
a/ Capacity dumping rate, assuming nonproductive time is 20 per cent of total work time.

b/ Wage rate: seton, $1.35; setoff, $1.10 per hour.

c/ Estimated as 0.5 per cent of replacement cost per 100 hours of use; power cost estimated at $0.03 per hour per motor horsepower.

d/ Price level for 1950.

e/ Estimate based on percentage of replacement cost; for dumping machine and conveyors = 13.5 per cent.



(A) (B)

Figure 7. Single-box dumping machines. (A) Field lugs are fed by conveyor from the left to a dumping table, which tips and empties the box, then delivers the empty box to an empty-lug conveyor on the right. (B) A twisted-chain conveyor, which inverts the full field lug (background) over a water-dumping tank; empty lugs are righted and continue on conveyor to the empty-lug storage area.

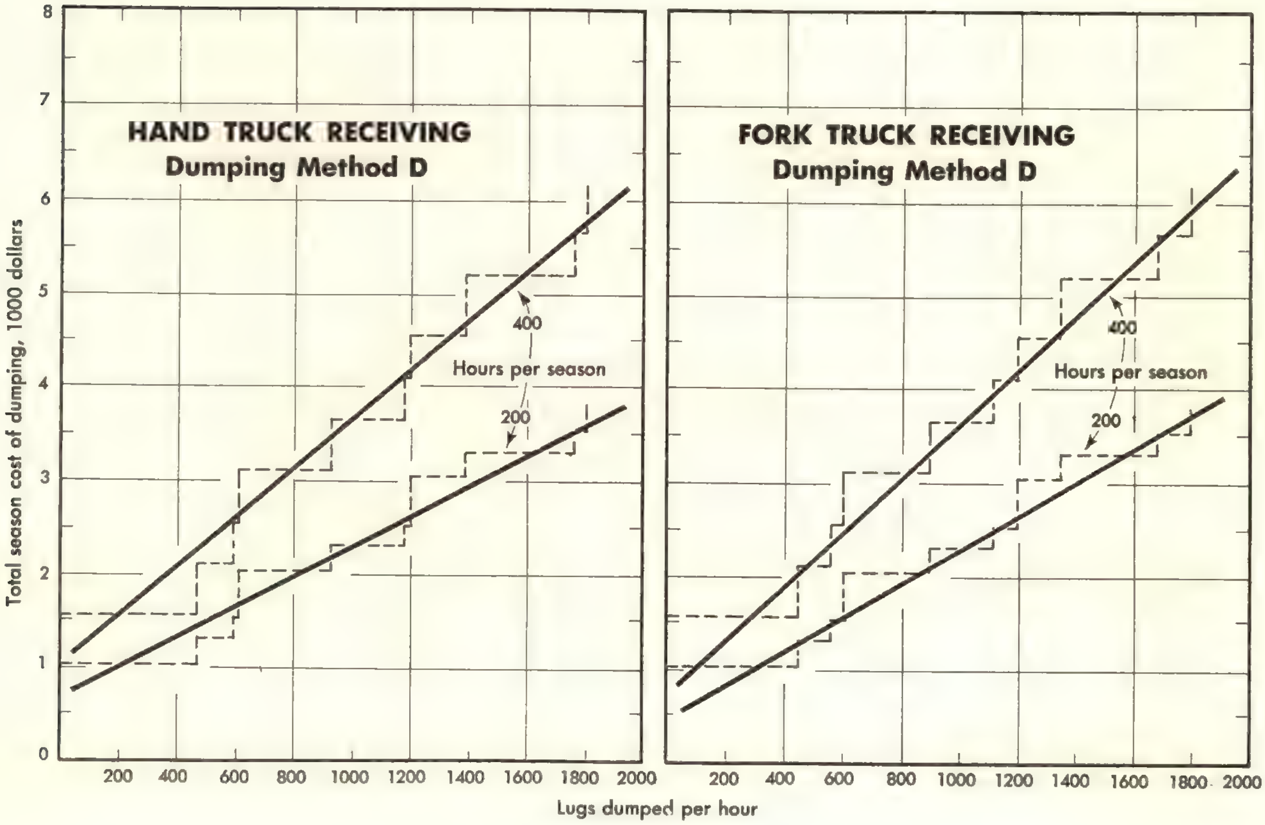


Figure 8. The effect of rate of operation on total season dumping costs with single-box machine dumping—Method D.

Method E--Stack Dumper

The procedure with this method is the same as with Method D--the single-box dumper--except that the full lugs are fed into the dumping machine in stacks of 5 or 6 lugs (Figure 9). The machine automatically destacks the lugs one at a time, empties the contents, and places the empty lug on the empty-lug conveyor. As the last box in the stack is dumped, a new stack is moved into place from a floor chain conveyor. Job categories, capacity rates, and equipment requirements per dumping station with the stack dumper are summarized below.

Method E

Job classification	Capacity rate	
	From floor	From pallet
	lugs per hour	
Trucker-seton: With hand truck, transfers stacks of full lugs from pallets adjacent to the floor chain conveyor to the conveyor. (This job required only in fork-truck plants.)	--	600[a]
Setoff man: Removes empty lugs from empty-lug conveyor and stacks them on the floor or on a pallet	585	555

Equipment requirements per dumping station	Estimated quantity[b]	Replacement cost, 1950
Dumping machine	1	$2,200 to 3,800
Dumping table	1	$ 500
Floor conveyor	20 feet	$ 610
Empty-lug conveyor:		
Power conveyor	40 feet	$ 560
Gravity conveyor	48 feet	$ 150
Fruit distribution belt	30 feet	$ 730

[a] Estimated capacity of trucker-seton is 780 lugs per hour, but the capacity rate of 600 lugs per hour indicated allows one trucker-seton man per machine.

[b] For a one-station plant. The average quantities per station vary slightly with the number of stations.

In the above summary, a range of replacement costs is given indicating the range in costs for equipment of different manufacturers. With each type of machine, the rate of dumping may be varied over a considerable range by means of a variable speed drive. The manufacturer's estimates of maximim dumping rate range from 800 to 1,200 lugs per hour. As with Method D, however, a standard capacity rate of 750 lugs per hour has been taken as a good "working" range. With a delay proportion of 20 per cent of the total work time, this provides an effective dumping rate of about 600 lugs per hour.

In the plants using hand trucks for the trucking operations, both the seton and dumping labor are eliminated. This is true also in the plants using fork trucks for the trucking operations, but in these plants a substitute worker is required to transfer stacks of full lugs from the pallets to the floor chain conveyor.[10/] In either type of plant, it is assumed that supervision of the machine operation can be provided by the hand trucker so that no special labor for machine care is required.

Direct costs and annual fixed costs for equipment required for the dumping operations with the stack dumper are given in Table 6. Because the dumping crew organization in the fork-truck and hand-truck plants is different, crew requirements and costs in relation to dumping rate are given separately in Table 6 for plants using hand trucks or fork trucks in the receiving operations.

In the plants with hand-truck receiving, the direct costs include only the cost of power and direct repair expense for the equipment, plus the labor cost for the empty-lug setoff men. In the fork-truck plants, however, an additional labor cost is included for a hand trucker who transfers stacks of full lugs from pallets to the floor conveyor.[11/] The costs of none of the other trucking operations are included.

A graphic representation of these cost estimates with seasons of 200 and 400 hours of operation is given in Figure 10. As with the single-box dumping machine, the cost estimates are based on the lower value in the range of replacement costs given for the stack dumper. If the high-cost figure is used, annual fixed costs per station would be about $220 more than indicated, and direct costs per station would be about $0.08 more per hour.

[10/] A machine for mechanically destacking lugs from pallets is reported to be under development in the Northwest, but equipment of this type is not yet available for plant use.

[11/] The transfer of lugs from pallet to floor conveyor could be made singly by a seton man, but the cost would be higher than with a hand truck.

TABLE 6

Machine Dumping, Stack Dumper--Method E: Dumping Labor and Equipment Requirements and Costs in Relation to Capacity Dumping Rate, Apple and Pear Packing Plants

Number of dumping stations	Crew capacity[a]	Job and number of workers[b]		Direct cost			Equipment cost	
		Setoff	Hand trucker	Labor	Equipment (power and repairs[c])	Total	Replacement cost[d]	Annual fixed cost[e]
	lugs per hour			dollars per hour			dollars	
	Hand-truck receiving							
1	585	1		1.10	0.30	1.40	4,750	641
1	600	2		2.20	0.30	2.50	4,750	641
2	1,170	2		2.20	0.59	2.79	9,325	1,259
2	1,200	3		3.30	0.59	3.89	9,325	1,259
3	1,755	3		3.30	0.87	4.17	13,900	1,877
3	1,800	4		4.40	0.88	5.28	13,900	1,877
4	2,320	4		4.40	1.15	5.55	18,475	2,494
	Fork-truck receiving							
1	555	1	1	2.35	0.30	2.65	4,816	650
1	600	2	1	3.45	0.30	3.75	4,816	650
2	1,110	2	2	4.70	0.58	5.28	9,457	1,277
2	1,200	3	2	5.80	0.59	6.39	9,457	1,277
3	1,665	3	3	7.05	0.87	7.92	14,098	1,903
3	1,800	4	3	8.15	0.88	9.03	14,098	1,903

[a] Capacity dumping rate, assuming nonproductive time is 20 per cent of total work time.

[b] Wage rate: setoff, $1.10; hand trucker, $1.25 per hour.

[c] Estimated as 0.5 per cent of replacement cost per 100 hours of use; power cost estimated at $0.03 per hour per motor horsepower.

[d] Price level for 1950.

[e] Estimate based on percentage of replacement cost; for dumping machines, conveyors, and hand truck = 13.5 per cent.

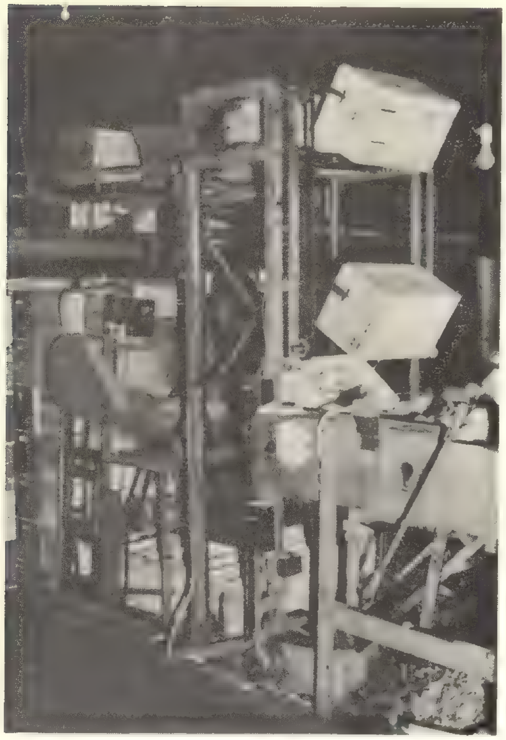


Figure 9. A stack dumper. Boxes are fed into the machine by a floor conveyor (rear). The boxes are automatically destacked and dumped; the empty boxes are placed on a conveyor to the empty-lug storage area (rear).

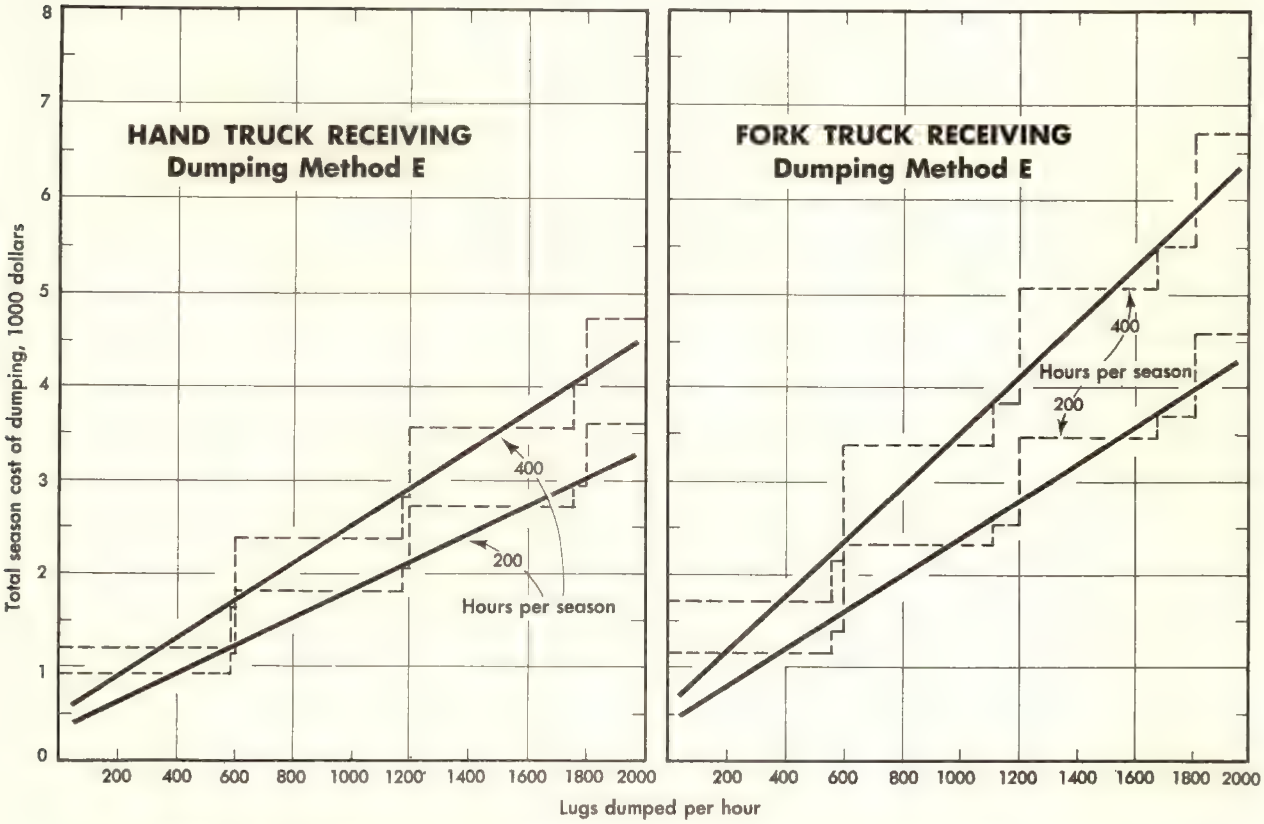


Figure 10. The effect of rate of operation on total season dumping costs with a stack dumping machine—Method E.

Trucking Costs in the Receiving Operations

As previously noted, the dumping and trucking operations in the receiving area of the plant are closely integrated. A comparison of costs with the different dumping methods, therefore, requires that the costs of dumping and trucking in the receiving area be studied jointly. Two situations with regard to the trucking operations are considered as follows:

> Method 1. The transportation of full and empty lugs is performed entirely with trucks--either hand trucks or fork trucks. This is the procedure followed with dumping Method A. The separate trucking operations include transporting incoming fruit to a temporary storage, then to a dumping station, and trucking empty lugs from the dumping station to a temporary storage, then to a grower's truck.
>
> Method 2. The trucking operations are similar to the above. The only differences are that full lugs en route to the dumping station from temporary storage are trucked to the full-lug conveyor rather than to the dumping station. Similarly, empty lugs en route to storage are trucked from a setoff point in the empty-lug storage area rather than directly from the dumping stations. In comparison with trucking Method 1, both of these changes reduce the trucking distances--especially in the larger plants--and thus reduce trucking costs.

Estimates of trucking costs with the above procedures may be made for a given rate of operation and a specified layout of equipment and storage areas. Data for such estimates are given in Table 7 for hand-truck and fork-truck equipment. The capacity rates indicated for the different trucking methods and types of equipment are based on standardized trucking distances and load sizes and on trucking time requirements determined from studies in a number of different plants.[12] Note that capacity rates in lugs handled per hour are given for both trucking methods. In Method 1, the trucking distance for empty lugs is longer as the number of dumping stations increases, and there is a corresponding decrease in the capacity trucking rate. In the hand-truck plant, for example, the capacity rate per trucker is 155 lugs per hour with only one dumping station and 135 lugs per hour with four dumping stations. Similar variations occur in the fork-truck plants. With Method 2, the use of conveyor equipment for the full and empty lugs permits the trucking distances to be standardized for plants of different size. The capacity rate per truck for this method is considered constant.

Estimates of trucking cost for any desired rate of receiving and dumping may be calculated from the capacity trucking rates and the annual fixed costs

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[12] For more detail regarding trucking distances and loads, see Appendix A.

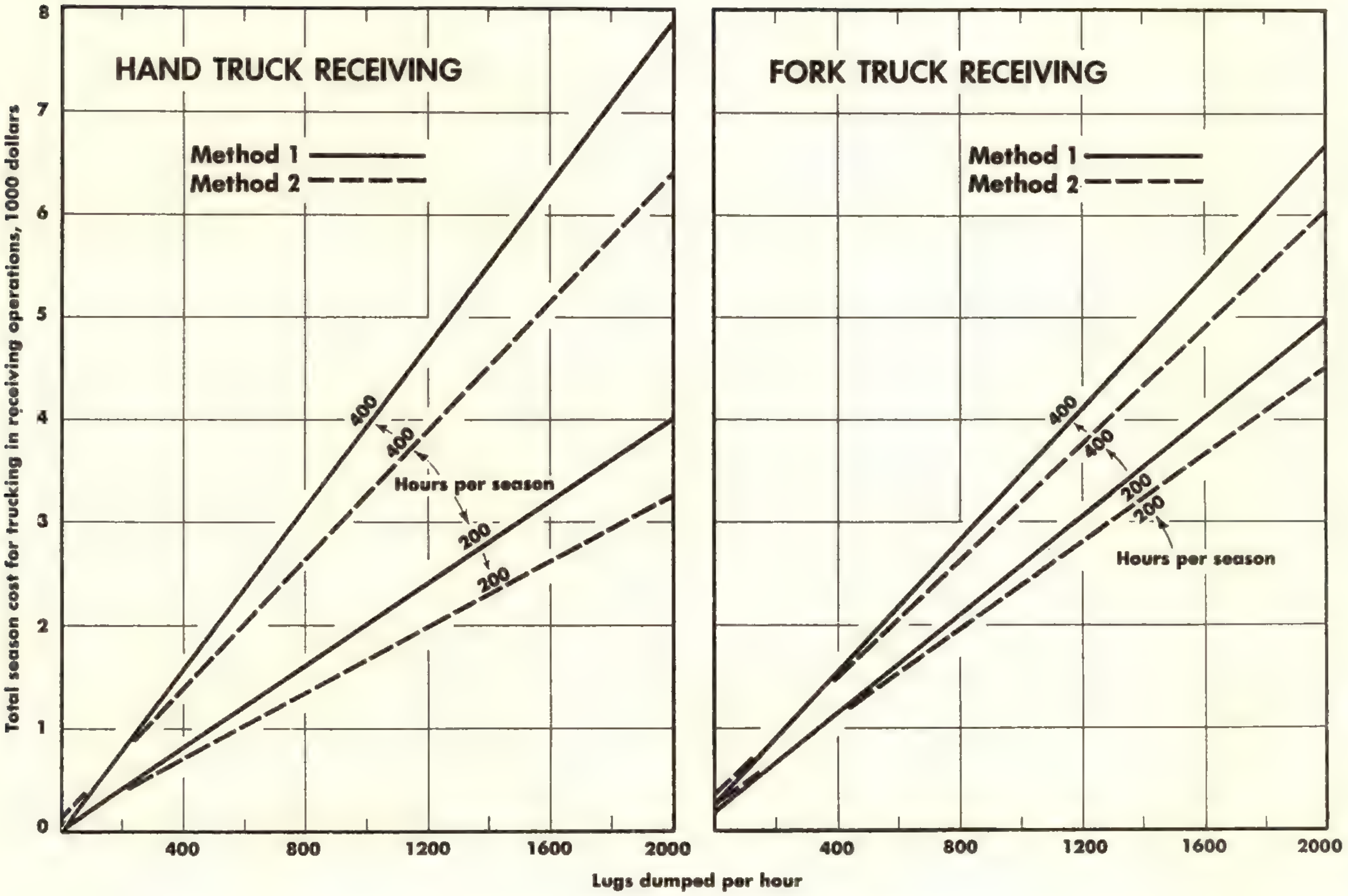

Figure 11. Total cost per season for the trucking operations in receiving incoming fruit—apple and pear packing houses.

TABLE 7

Capacity Rate of Receiving Per Hour and Direct and Fixed Costs for Hand Trucks and Fork Trucks

Type of equipment and trucking procedure	Capacity rate per truck	Direct and fixed costs per truck[a]	
	lugs per hour		
Hand trucks			
Without conveyor aids		Fixed costs per truck	
One dumping station	155	Replacement: hand truck	$ 66.00
Two dumping stations	150	Annual fixed cost at 13.5 per cent[b]	$ 8.90
Four dumping stations	135		
		Direct costs per truck	
With conveyor aids		Labor, per hour	$ 1.250
One to four dumping stations	165	Direct repair expense, per hour	$ 0.003
		Total, per hour	$ 1.253
Fork trucks			
		Fixed costs per truck	
Without conveyor aids		Replacement:	
One dumping station	450	Fork truck and pallets[c]	$3,700.00
Two dumping stations	440	Annual fixed cost at 16.5 per cent[b]	$ 670.00
Four dumping stations	420		
		Direct costs per truck	
		Labor, per hour	$ 1.300
With conveyor aids		Direct repair expense, per hour	$ 0.185
One to four dumping stations	465	Gasoline and oil, per hour	$ 0.150
		Total, per hour	$ 1.635

a/ Price level for 1950.
b/ See page 7 for breakdown of percentage annual charge.
c/ Approximately 210 field pallets per truck. This number is estimated to be adequate for 1½ to 2 days' operation without reuse of pallets.

for equipment given in Table 7. The procedure is similar to that followed previously in estimating the costs of dumping. The results of such calculations for hand-truck and fork-truck equipment are presented in Figure 11 in which total season costs for the two trucking situations are given for 200 and 400 hours of operation per season. With either type of truck, the costs with Method 2 are substantially less than with Method 1. These costs, however, do not include the cost of the lug conveyors used with trucking Method 2, and the net effect of the differences in method must be evaluated by bringing the costs of dumping and trucking together. This is done in the following section.

SUMMARY--
COMPARISON OF DUMPING AND RECEIVER-TRUCKING COSTS WITH DIFFERENT METHODS

In this section, the labor and equipment costs for trucking and dumping field lugs are compared for different dumping methods. This is done by combining the estimated costs given separately in the preceding sections for dumping and trucking to obtain a total cost for the combined operations.

Consider, for example, a fork-truck plant in which the lugs are hand dumped without conveyor aids--Method A--and the rate of dumping is 1,000 lugs per hour. The length of season is 200 hours. Total season costs for dumping in such a plant are given in Figure 3 as $1,200, and total season costs for the trucking operations are given in Figure 11 as $2,600. Total dumping and trucking costs are then $3,800 per season. Similarly, if the lugs are hand dumped--but with conveyor aids as in Method B--the total cost of the dumping and trucking operations in receiving may be obtained as $5,000.

Comparisons similar to the above may be made for other rates of dumping and for other methods. It is difficult, however, to obtain a comprehensive view of the relative costs with different methods from this point-by-point comparison. One problem is that some of the methods require relatively large quantities of equipment and so have correspondingly high annual fixed costs. For this reason, an important factor in comparing methods having large differences in equipment costs is the length of operating season. To take this into account, the comparisons that follow are made in terms of total season cost for plants operating at a given dumping rate but with the length of season varied. As costs with a given dumping method are affected by the type of trucking equipment used, separate comparisons are made for hand-truck and fork-truck receiving.

Fork-Truck Receiving

Total season costs with a dumping rate of 1,000 lugs per hour are shown in relation to hours of plant operation per season in Figure 12. Comparison of the cost lines for the various methods indicates that costs with Method A--hand dumping without conveyor aids--are lowest for any length of season. For example, with 250 hours of operation per season, costs with Method A are approximately $4,200 per season in contrast with costs of $5,700 per season with Methods B and C--hand dumping with conveyor aids--and $5,300 per season with machine dumping, Methods D and E.

The capacity dumping rate per station with Method A, however, is only 340 lugs per hour, and if the "line" requirements imposed by the equipment for sorting and packing require a higher dumping rate, one of the other methods must

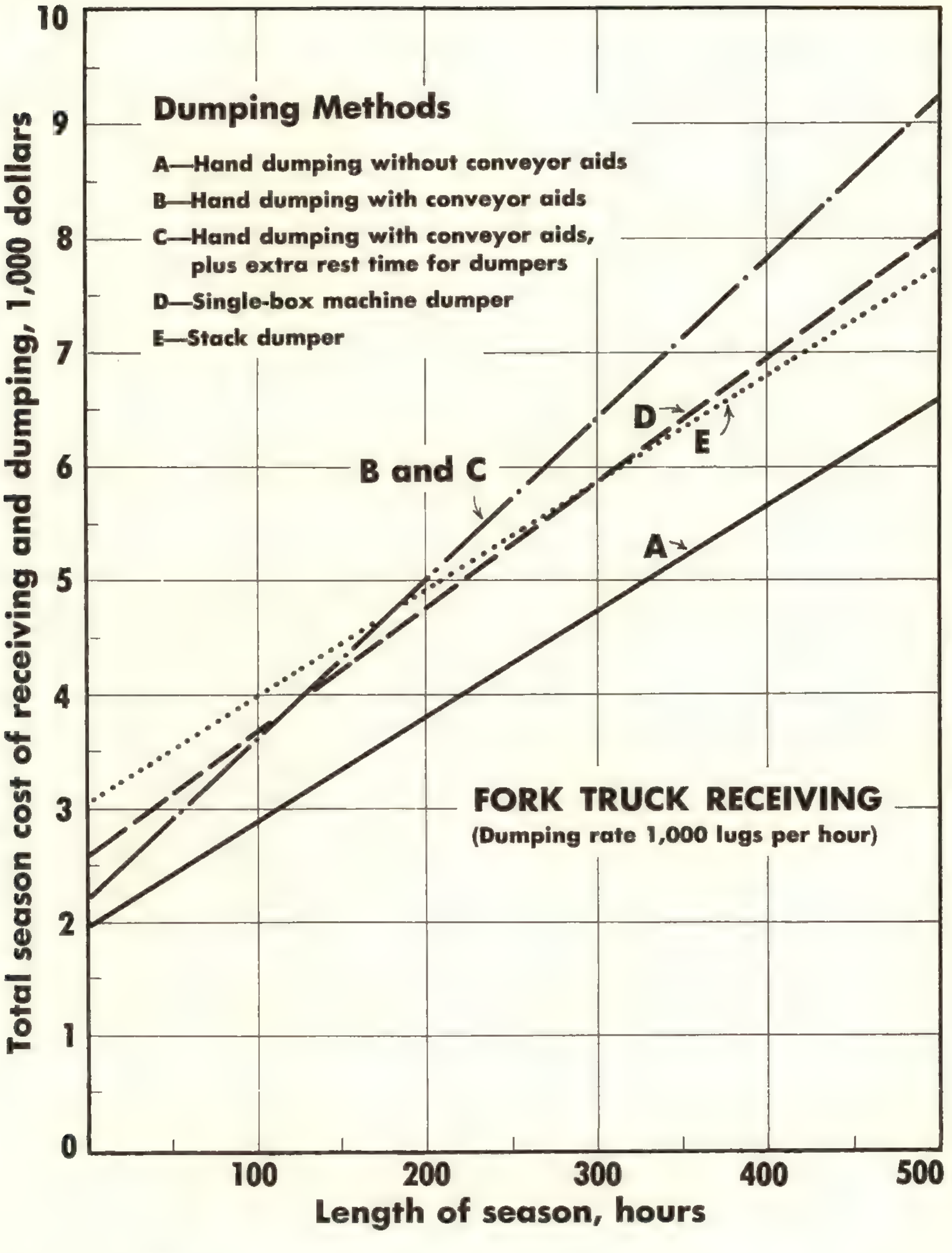

Figure 12. Effect of work methods and type of equipment on total season costs for receiving and dumping field lugs in apple and pear packing plants—fork-truck receiving. (Dumping rate, 1,000 lugs per hour.)

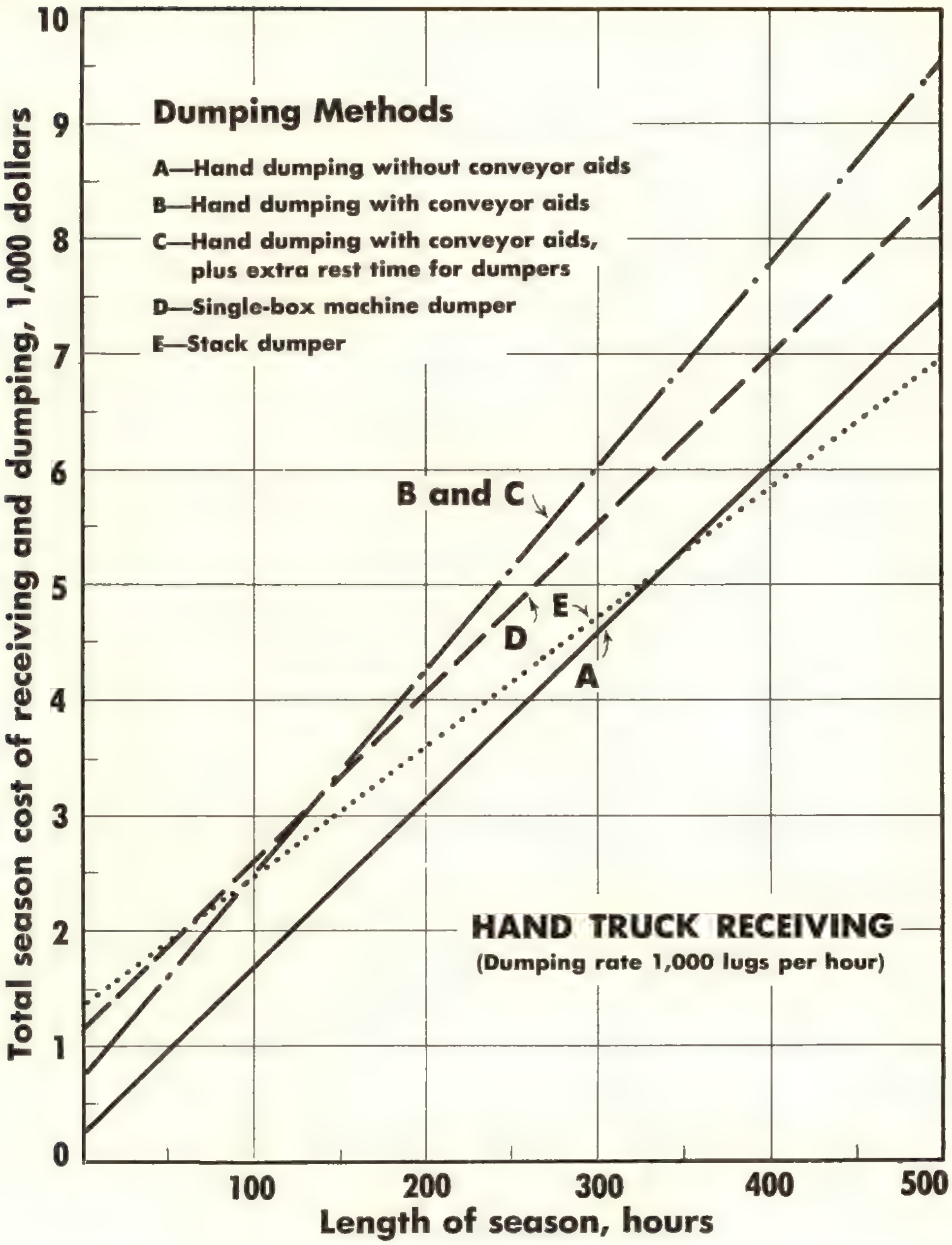

Figure 13. Effect of work methods and type of equipment on total season costs for receiving and dumping field lugs in apple and pear packing plants—hand-truck receiving. (Dumping rate, 1,000 lugs per hour.)

be used even though costs are higher. In this event, a choice is possible between the machine-dumping methods and hand dumping with conveyor aids. From Figure 12 it appears that hand dumping with conveyor aids will be less costly than machine dumping for seasons less than about 150 hours of operation. For longer seasons, costs are less with machine dumping than with hand dumping. Comparison of the single-box dumper--Method D--with the stack dumper--Method E--indicates that costs will be lower with the stack dumper if the length of season exceeds about 300 hours.

Hand-Truck Receiving

Season costs for dumping and receiving at a rate of 1,000 lugs per hour in a hand-truck plant are shown in Figure 13. Excepting Method E, the results are much like the comparisons in the preceding diagram. Method A is the most economical for any length of season. Also, for dumping rates per station higher than 350 lugs per hour--the maximum rate with Method A—relative costs with Methods B, C, and D are about the same as in the fork-truck plant. Thus, season costs with Methods B and C--hand dumping with conveyor aids--are less than with the single-box dumper for seasons shorter than about 150 hours, and costs are higher with the hand-dumping method for longer seasons.

Relative costs with Method E are lower with hand-truck receiving than with fork-truck receiving. This is because the floor chain conveyor makes it possible to eliminate the seton operation with no additions to the trucking costs. The stack dumper, therefore, may be used more advantageously with hand-truck receiving than with fork-truck receiving. Thus, the stack dumper is more economical than the single-box machine dumper or hand dumping with conveyor aids for seasons longer than about 50 hours of operation, and of all the methods, costs with the stack dumper are least for operation longer than about 300 hours per season.

The savings possible through choice of the most economical method can be indicated by comparing total season costs. The amount of the saving will depend on the length of season. With a season of 250 hours of operation, Figure 13 indicates that total season costs with Methods B and C are about $5,100; with Method D, $4,800; with Method E, $4,100; and with Method A, $3,900. If the dumping rate per station need not exceed 350 lugs per hour, the use of Method A would save $200 in contrast with Method E, $900 in contrast with Method D, and $1,200 in contrast with Methods B and C. If a dumping rate greater than 350 lugs per hour is required, the use of Method E would save $700 per season in contrast with Method D and would save $1,000 per season in contrast with Methods B and C.

The above comparisons indicate in a general way the relative costs that may be expected with different dumping methods. The details as to labor and equipment requirements and costs that are given for each method discussed in this report may be used by the packing house manager to estimate possible savings through changes in method in his own plant.

APPENDIX A

The general procedure followed in estimating equipment requirements and costs with different dumping methods is presented in the preceding discussion. In this appendix, the basic cost and production data for the various methods are brought together in summary form. Some additional details regarding the production standards for trucking and dumping are presented.

Cost Data

Wage rates for the various job categories in receiving and dumping are summarized in Table A. In the plants studied, the observed wage rates varied considerably, but the rates given in the table are considered typical. Wage rates in the apple packing plants were generally lower than the rates prevailing in the pear packing houses.

TABLE A

Typical Wage Rates for Job Classifications in Receiving and Dumping Operations, Apple and Pear Packing Plants

Job	Wage rate
	dollars per hour
Dumper	1.35
Set on full lugs	1.35
Set off and stack empty lugs	1.10
Trucker: Hand truck	1.25
Fork truck	1.30
Trucker: Alternate with dumper or seton	1.30

For reference purposes, data regarding costs for the principal items of equipment required in the dumping and trucking operations are summarized in Table B. These data include the estimated replacement cost in 1950, the estimated percentage annual charge, and annual fixed costs for each type of equipment. For all types of equipment, the percentage annual charge includes the following: insurance, 1.0 per cent; taxes, 1.0 per cent; interest, 3.0 per cent;[13] and fixed repair costs, 1.5 per cent. These items total 6.5 per cent, and the remainder of the percentage indicated for each item in the table is the percentage charge for depreciation based on the estimated use life.

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[13] Approximately 5.0 per cent on the undepreciated balance.

TABLE B

Fixed Costs and Direct Costs Per Hour of Operation for Equipment Required in Receiving and Dumping Operations, Apple and Pear Packing Plants

Item	Fixed cost			Direct cost, excluding labor		
	Estimated replacement cost[a]	Estimated annual charge	Estimated annual cost	Repairs[b]	Power[c]	Total
	dollars	per cent of replacement cost[d]	dollars	dollars per hour		
Conveyor:						
Gravity, side wheel 8-foot section	25	11.5	2.90	0.0013	--	0.0013
Power, 12-inch belt on steel rolls:						
20-foot section	480	13.5	64.80	0.0240	--	0.0240
100-foot section	1,200	13.5	162.00	0.0600	0.03	0.0900
Power, 12-inch belt on wood rolls:						
20-foot section	430	13.5	58.00	0.0215	0.02	0.0415
100-foot section	970	13.5	131.00	0.0485	0.03	0.0785
Power, floor chain conveyor:						
20-foot section	610	13.5	82.50	0.0305	0.02	0.0505
100-foot section	2,200	13.5	297.00	0.1100	0.03	0.1400
Dumping table:						
With elevator	500	13.5	68.00	0.0250	0.02	0.0450
With water tank and elevator	770	13.5	104.00	0.0480	0.02	0.0680
Dumper, machine:						
Chain dumper, each	1,100	13.5	148.50	0.0550	0.02	0.0750
Single box, each	1,100 to 2,600	13.5	148.50 to 351.00	0.0550 to 0.1300	0.02	0.0750 to 0.1500
Stack dumper, each	2,200 to 3,800	13.5	297.00 to 513.00	0.1100 to 0.1900	0.02	0.1300 to 0.2100
Pallets, each	3.5	16.5	0.06	0.0002	--	0.0002
Trucks:						
Fork truck, 4,000-pound-capacity gas engine, each	3,300	16.5	544.50	0.1650	0.15	0.3150
Hand truck, each	66	13.2	8.70	0.0033	--	0.0033

(Continued on next page.)

Table B continued.

a/ Installed price, 1950.

b/ Estimated as 0.5 per cent of replacement cost per 100 hours of use.

c/ For electric motors: computed at rate of \$0.03 per rated motor horsepower; for fork trucks, gasoline, and oil at the rate of \$0.15 per hour of use.

d/ Includes a percentage allowance for depreciation, plus the following: insurance, 1.0 per cent; taxes, 1.0 per cent; interest, 3.0 per cent--approximately 5.0 per cent of undepreciated balance; fixed repair expense, 1.5 per cent.

Direct costs for each type of equipment--excluding labor--consist of the following: direct repairs, estimated as 0.5 per cent of the replacement cost per 100 hours of use; power costs for electric motors, estimated as $0.03 per rated horsepower per hour of use; and fuel costs for fork trucks, estimated as $0.15 per hour per 4,000-pound-capacity fork truck.

Production Standards

The amounts of equipment and labor required for a given dumping rate are based on standardized production rates. These rates were derived from net unit time requirements obtained by studies of dumping and trucking operations in a number of plants. The net unit time requirements obtained from these studies have been adjusted to allow for nonproductive time as follows:

Item	Per cent of total work time
Scheduled rest periods: Ten minutes per four hours worked	4.2
Break-for-lots time: Range in the plants studied was from 2.2 to 27.9 and averaged 9.3 per cent	9.3
Unavoidable and "other" delay: Range in the plants studied was from 1.0 to 15.9 and averaged 6.3 per cent	6.3
Total	19.8

Production standards for the various dumping jobs are given in Table C with nonproductive time estimated as 20 per cent of the total work time. The production standards would, of course, be different with other allowances for "delay," and the level of output would be approximately 10 per cent higher than indicated if the break-for-lots delay were eliminated through the use of a sampling procedure to account to the growers for fruit delivered.

Unit time requirements are given with both hand-truck and fork-truck receiving. For operations such as "hand dumping" or "seton," the difference in time required per lug consists of an allowance for handling the empty pallet. On logical ground, it appears that the unit time requirements in fork-truck plants should be still greater because of the slightly longer reach involved in grasping

TABLE C

Unit Labor Requirements and Capacity Rate Per Hour for Various Field Lug Dumping Operations

Job	Hand truck			Fork truck[a]		
	Net time	Gross time[b]	Capacity	Net time	Gross time[b]	Capacity
	minutes per box		boxes per hour	minutes per box		boxes per hour
Set off empty lugs						
Stack singly, floor or pallet	0.103	0.129	465	0.107	0.134	450
Stack, two lugs at a time	0.082	0.103	585	0.086	0.108	555
Stack, nests of three boxes	0.063	0.079	760	0.067	0.084	715
Set on full lugs (to conveypr)						
No relief, or alternate with dumper	0.104	0.130	460	0.108	0.135	445
Relief: rest, or rest and trade jobs (not with dumper)	0.075	0.094	640	0.079	0.099	605
Dump full lugs--hand						
Without conveyor aids or relief	0.177	0.221	270	0.181	0.226	265
Without conveyor aids, trade with trucker	0.137	0.171	350	0.141	0.176	340
With conveyor aids, no relief	0.128	0.160	375	0.132	0.165	365
With conveyor aids, trade with seton	0.104	0.130	460	0.108	0.135	445
With conveyor aids, trade with seton, 20-per cent rest	0.078	0.098	610	0.082	0.102	590

a/ "Move pallet" time prorated on basis of 36-lug pallet. Prorated time = 0.154/36 = 0.004 minutes per lug.

b/ Based on delays as follows: rest = 4.2 per cent; BFL = 9.5 per cent; other = 6.3 per cent; total = 20.0 per cent of gross time.

a full lug from a pallet or in disposing of an empty lug. Such differences, however, were not revealed by the studies.

For the setoff and seton men, the "capacity rate" indicated is actually an average rate based on observed performance in a number of different plants. For the hand-dumping operation, however, a meaningful "average" performance was difficult to measure as the dumping operation is a fixed station job on which the rate of dumping is governed by the requirements of the grading and packing lines served by each dumping station. In other words, the job is "line paced," and the rate of dumping observed in a given plant reflects the line requirements rather than the normal working rate of the dumper. For this reason, the capacity rate for the dumping operation is based on the lower of the observed time requirements for each method. These time requirements were obtained by time study for short periods and were verified by continuous studies of output over a period of three or four days. Hence, the capacity rate for hand dumping may be regarded as an attainable rate for the method specified. When the line requirements are less than the capacity rate for the dumping method used, the dumping rate will be slower than indicated in Table C or there will be a higher proportion of idle time. If the line requirements exceed the capacity rate for a given method by more than a small amount, it is likely that a dumping method of higher capacity will be required.

With some methods, an increase in capacity rate may be possible by a very simple change. For example, the capacity rate of hand dumping without conveyor aids is given in Table C as 270 lugs per hour. But if the dumper alternates with a worker on a different job such as trucking, the capacity rate of dumping is 350 lugs per hour. In methods using hand dumping with conveyor aids, the capacity dumping rate is increased from 375 to 460 lugs per hour if the dumper alternates with the seton man, and a still greater rate of dumping may be attained if sufficient relief is provided to permit additional rest time amounting to 20 per cent of the total work time.

Estimates of the labor requirements for trucking are based on standardized conditions as to load size and transport distance for each type of equipment. These standards are considered typical of the plants studied. Capacity rates per trucker--based on these standards--are derived from estimates of trucking time requirements obtained by study of trucking operations in a number of plants.[14]

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[14] For greater detail regarding trucking requirements and costs, see In-Plant Transportation Costs as Related to Materials Handling Methods, Apple and Pear Packing. Berkeley, 1953. (Calif. Univ. Giannini Foundation of Agricultural Economics. Mimeographed Report 142)

The trucking distances, load sizes, and capacity rates per trucker obtained through the above procedures are summarized for the various trucking jobs in Table D. In the plants not using conveyors for empty lugs, the transport distances increase as the number of dumping stations increases. This is reflected in the range of trucking distances and capacity rates per trucker given in the table for transporting empty lugs from the dumping station to the empty-lug storage. In plants using conveyor equipment in conjunction with the dumping--and for the remaining trucking jobs--the distances are uniform over a range of plant sizes.

TABLE D

Standardized Trucking Distances and Load Sizes and Estimated Capacity Rate Per Trucker for Various Trucking Operations in Receiving in Apple and Pear Packing Plants

Job	Fork truck			Hand Truck		
	Size of load	Trucking distance	Capacity	Size of load	Trucking distance	Capacity
			lugs per hour			lugs per hour
Unload grower's truck	36	90	1,380	6	50	450
Truck to dumping station	36	50	1,840	6	30	610
Truck empty lugs to storage						
Without empty-lug conveyor:						
One line	36	60	2,125	9	30	985
Two lines	36	80	1,890	9	55	710
Four lines	36	120	1,555	9	100	475
With empty-lug conveyor:						
One to four lines	36	40	2,425	9	30	985
Truck empty lugs to grower truck	36	40	2,110	9	30	805
Truck full lugs from pallet to floor conveyor	6	15	780			

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